5

The Capture and Care of a Killer Whale, *Orcinus orca*, in British Columbia

MURRAY A. NEWMAN

Vancouver Public Aquarium
Stanley Park, Vancouver, B. C.

PATRICK L. MCGEER

Kinsmen Laboratory of Neurological Research
University of British Columbia
Vancouver, B. C.

(Plates I-VIII; Text-figures 1 & 2)

INTRODUCTION

ALTHOUGH a dozen or more species of small cetaceans have been captured and maintained alive for varying lengths of time, only one capture of a killer whale *(Orcinus orca)* is recorded in the literature (Caldwell & Brown, 1964). That specimen was evidently ill and lived only 18 hours after being caught in a large net off Southern California.

The attempted capture of an adult female by Marineland of the Pacific collectors in northern Washington in September, 1962, resulted in the animal tangling the line around the propeller and attacking the boat (personal communication from Frank Brocato). Fearing that the boat would be damaged, the collectors killed the animal.

Killer whales are most abundant in the waters of British Columbia in late spring, summer and early fall (Table 1), while in Southern California they are most often observed in fall, winter and early spring (Norris & Prescott, 1961). This may possibly indicate a seasonal migration, but some individuals remain in the north during the winter and they have been recorded in Puget Sound at all seasons (Scheffer & Slipp, 1948).

They are particularly common during the summer in the Strait of Georgia and Johnstone Straits, where they often gather in large numbers in association with the migrations of salmon and herring. The whales are frequently seen near the mouths of the Fraser and Campbell Rivers in summer by both commercial and sports fishermen. While they are the best known and most abundant species of whale in these inland waters, they may swim far offshore, where they are occasionally seen by the crew of the Department of Transport weather station "Papa" at 50°N Latitude, 145°W Longitude, approximately 970 km. west of Vancouver Island (Pike & Giovando, 1963).

HISTORY

East Point, Saturna Island, is a narrow peninsula of land with steep, sandstone cliffs that drop off into many fathoms within a few meters of the shore.

Vancouver Public Aquarium collectors mounted a harpoon gun there on May 20th, 1964, with the intention of killing a specimen as a basis for the preparation of a replica for the Aquarium's new British Columbia Hall.

Eight pods of *Orcinus,* totalling about 60 whales, were observed during the 57 days of waiting. All came from the direction of the Strait of Juan de Fuca and the open ocean. Dates of sighting were May 22, 24, 26, 28, June 25, July 2 and July 16. Almost a month passed between May 28 and June 25 without a sighting.

The collecting crew harpooned a young male orca on July 16 (Fig. 1). A harpoon 117 cm. long and 5 cm. in diameter, with 36 cm. spread flukes and weighing 6.8 kg., was fired from the shore. The whale was struck as it was swimming parallel to the cliffs, about 20 meters from land.

Table 1
Killer Whales Seen from East Point Lighthouse
Saturna Island
1958-1963*

Month	Total Seen	Average Number	Remarks
Jan.-Feb.	64	Av. for 3 yrs—0.4/day	Seen infrequently, none in 1961 and 1962.
March	38	Av. for 3 yrs—0.4/day	Seen infrequently, none in 1961 and 1962.
April	52	Av. for 5 yrs—0.4/day	Seen infrequently, mostly going north.
May	332	Av. for 5 yrs—2.2/day	Increasing; going north and south. Many young.
June	466	Av. for 5 yrs—3.0/day	Increasing. More going south.
July	463	Av. for 5 yrs—3.0/day	As for June.
August	631	Av. for 6 yrs—3.4/day	Peak month. Larger groups. Mostly going north.
Sept.	344	Av. for 4 yrs—2.9/day	Decreasing. Mostly going north. None reported in 1959.
Oct.	220	Av. for 4 yrs—1.8/day	Decreasing.
Nov.-Dec.	—	—	None.

*Compiled by Mrs. Peter Fletcher and made available by Ian MacAskie of the Fisheries Research Board, Nanaimo, B.C.

The harpoon entered the left side of the body, just posterior to the calvarium and dorsal to the vertebral column, and passed completely through (Fig. 2).

The whale appeared to be stunned by the shot. Two other whales assisted it to the surface for the first two or three minutes. The animal slowly recovered and began swimming and breathing normally. It headed toward the remaining whales in the pod, numbering about 12, which held their position at the surface some distance away. A 12-meter fishing boat, which had been waiting nearby, then retrieved the floats on the end of the 203-meter harpoon line, and the wounded whale struggled vigorously for a few moments. Soon afterwards it ceased to struggle, seeking instead to avoid the boat.

The whale was towed into shore and tied briefly to a mooring while an attempt was made to assess its injury. Spectators soon descended on the scene in boats frightening the whale, which swam into a bed of kelp. At this point it became extremely distressed and uttered shrill whistles so intense that they could easily be heard above the surface of the water 100 meters away. The animal was quickly towed out to deeper water in the channel, and it was then decided to tow it to drydock in North Vancouver, 80 kilometers away, where more detailed observations could be made. This trip took 16 hours.

The whale was pulled into the dock by the line held to a stage suspended over the dock from a movable crane (Fig. 3). Upon entering the drydock, the animal commenced swimming in slow counterclockwise circles, a pattern it continued to follow throughout its life in captivity.

The whale manifested no apparent distress either from the wound or the voyage, and plans were initiated to maintain it in captivity.

The rope was removed the next day and the whale given 30 million units of S.R. penicillin as a prophylactic measure against wound infection. This was injected just anterior to the dorsal fin through a 100 mm. #15 needle.

Six days after capture, the animal was given another 15 million units of S.R. penicillin with a syringe mounted at the end of a 2.5 m. pole (Fig. 4). One gram of thiamine was injected by a "capture gun" into the mid-dorsal region.

A semi-permanent pen, 14 m. x 23 m., was constructed inside an abandoned pier at the Canadian Army Base, Jericho, in Vancouver's outer harbor. The pilings were torn from the middle of the pier and the sides lined with chain link wire fencing. The location was not far from the mouth of the Fraser River, where the water conditions vary considerably. The water at times was fairly clear, with a surface saline content of 23 per thousand. At other times it became extremely muddy, and the saline content dropped as low as 12 to 15 per thousand. Depth of water within the pen varied with the tide from 3 to 6 m. at the shallow end and 4 to 7 m. at the deep end.

The drydock was towed to the new location

on July 24, 1964, and the whale transferred. Although the whale had not eaten, it appeared to be in good health with the harpoon wound healing.

The whale continued to reject all offerings of food and held its distance from people on the dock. It never demonstrated aggressive tendencies of any kind. For a brief period, the whale was studied by an observer on a small raft. It could easily have overturned the raft but never more than brushed against it.

On August 6, 1964, the whale was netted and restrained at one end of the pool. The wound was inspected and found to be healing well. A blood sample was taken. The animal was injected with 30 million units of S.R. penicillin, one gram of thiamine, 1.5 mg. of vitamin B_{12} and one gram of Hydroxyzine hydrochloride (atarax) just anterior to the dorsal fin.

During the last week of August, lesions began to appear on the skin (Fig. 5). These lesions, caused by a fungus, progressed relentlessly until the animal died.

On September 9, the whale was first observed to devour a fish suspended on a line into the pen. The same day it ate 90 kg. of lingcod similarly suspended. The next day, it was fed fish suspended from the raft inside the pen and thereafter was fed by hand (Fig. 6).

On October 9, 1964, it took three fish but refused to rise out of the water at all to obtain them. After swimming listlessly for a few minutes, it gave an abortive blow while partly underwater and then sank out of sight.

The whale was lifted out of the water two and one-half hours later and an autopsy commenced. During the last two days of its life, the saline content of the pen reached the lowest recorded level, 12 per thousand.

Sounds

Extensive recordings were made of the sounds of the captive whale using a barium titanate hydrophone.

In common with porpoises and dolphins, the killer whale emitted two distinct classes of sounds. The first class consisted of whistles and squeaks, which were presumably for communication. The second class consisted of clicks, evidently for the purpose of echo location.

The whistles were varied in nature. The "whee-ooo-eee" sound most frequently heard is shown sonographically in Fig. 7. This sound was heard in a wide variety of behavioral situations. It was heard during the approach for food, when it was being netted, when it was being transferred to its new pen and when it was swimming around in the absence of any disturbances. Some sounds were clearly coordinated with the expiration of air from the blowhole as (Wood, 1953) described in both *Tursiops* and *Stenella,* although this was the exception rather than the rule.

A typical train of navigational clicks is shown in Fig. 8. These clicks were occasionally blended with whistles, but the two types of noise were never emitted simultaneously as has been reported for *Tursiops truncatus* (Lilly & Miller, 1961). The upper limit of the hydrophone was 15,000 cps. No sounds seemed to be near this upper cut-off frequency.

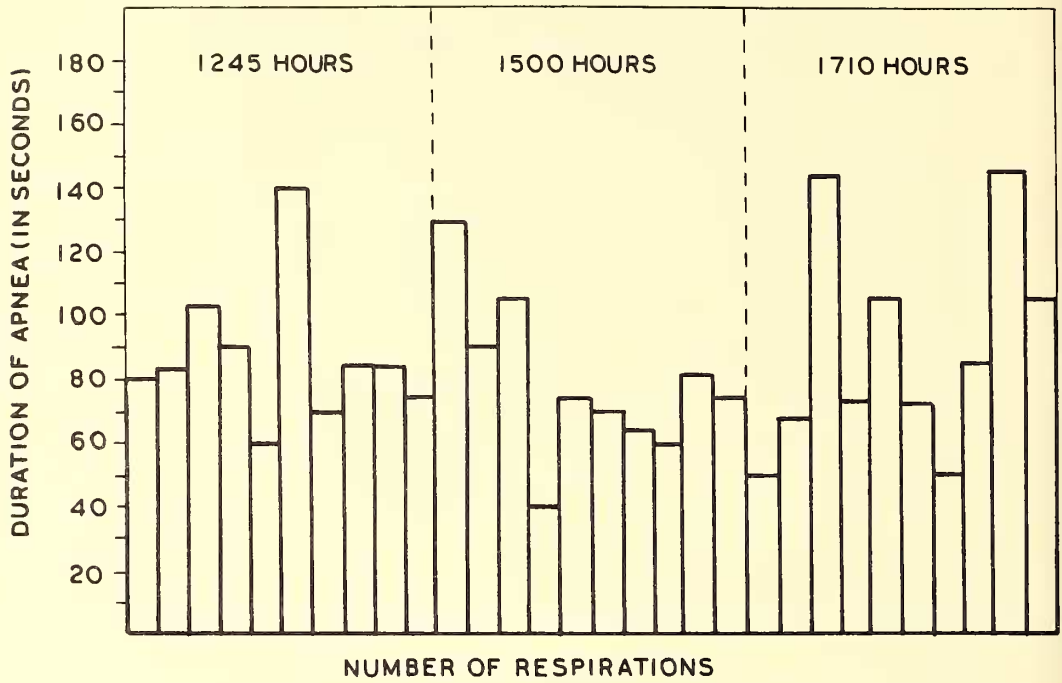
On many occasions, the whale collided with lines suspending fish in the pen. This happened both in the dark and under conditions of good visibility. The large size of the animal retarded maneuverability within the pen and it apparently had difficulty in avoiding suspended lines. The degree of echo locating accuracy attributed to *Tursiops* by Kellogg (1961) was never determined for *Orcinus* and the despondence of the animal during its period of starvation and isolation may have affected this ability. Orcas must nonetheless possess considerable ability at echo locating as they are known to be skillful in avoiding fishermen's nets.

Feeding Behavior

The whale was offered food from the first day in captivity, but it is unlikely that very much, if any, was consumed prior to the 54th day. Live and dead fish, horse heart, live and dead poultry, live and dead octopus, squid, whale tongue, whale meat and blubber, and live and dead seals were offered at various times.

From the first day of known feeding, consumption went to 45 to 90 kg. per day. A few fish each day were stuffed with vitamin pills and minerals. Once feeding began, it showed marked preferences. The main food accepted by the whale was soft-rayed fishes such as salmon *(Oncorhynchus spp.),* lingcod *(Ophiodon elongatus)* and Pacific cod *(Gadus macrocephalus).* Some rough, spiny rockfishes *(Sebastodes spp.)* were accepted, but many were rejected. Ratfish *(Hydrolagus colliei)* were accepted after removal of their sharp dorsal spines, but dogfish sharks *(Squalus suckleyi)* were rejected even after removal of the spines. Lingcod and Pacific cod were preferred to squid and horse heart, but both of the latter were taken in limited amounts.

The whale used its teeth merely for grasping the fish and never for chewing. In most cases, it would swallow the fish immediately, head first, although occasionally it would swim for a time with the fish held crosswise in its mouth before rotating it with the tongue and swallowing it.



TEXT-FIG. 1. Duration of submergence (apnea) in captive *Orcinus orca* on August 12, 1964, before it began feeding.

At feeding time, the whale would usually swim in tight circles, about 10 meters in diameter, near the raft from which it was fed. At some distance away, it could usually be summoned by slapping the water with a fish. It swam slowly to the corner of the raft to accept the fish and would rise partly out of the water to reach food held two or three feet above the surface. It always took the food in a slow and deliberate manner.

The feeder became very confident of the whale's harmlessness, occasionally patting it on the head as it approached for food, and, by slowly rotating the fish over the whale's head, causing the animal to turn over on its back. *Tursiops* and *Inia* also swim upside down occasionally and probably other cetaceans do it, too (Layne & Caldwell, 1964).

General Behavior

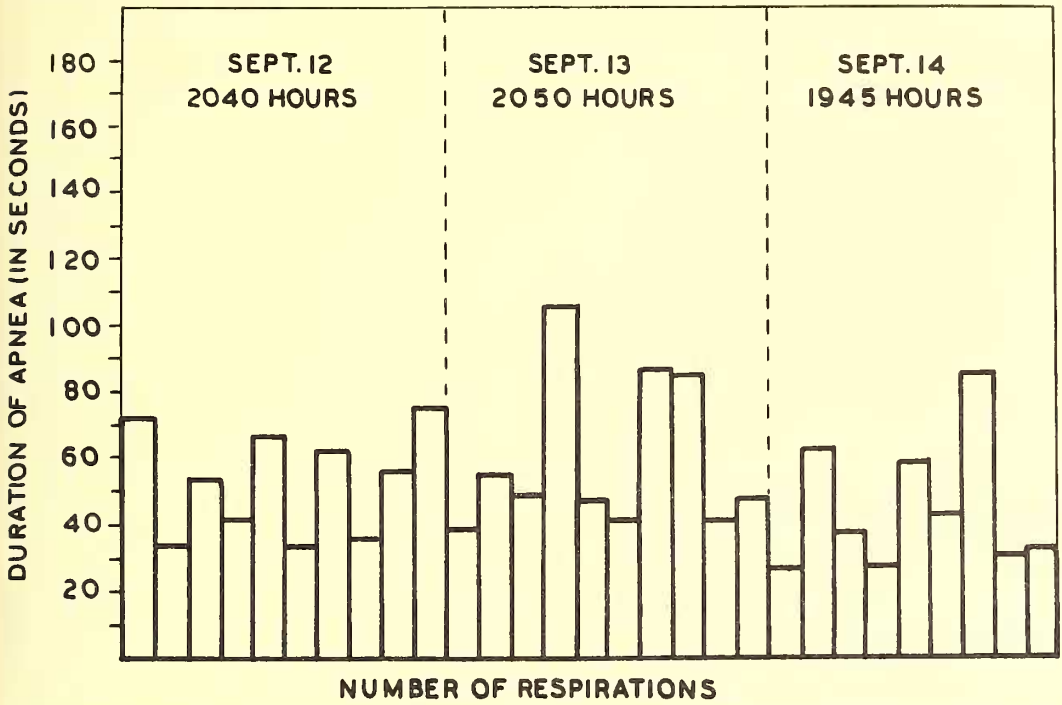
The most astonishing aspect of the behavior was the complete lack of ferocity or aggressiveness. At no time did it make any hostile moves towards any human involved in the capture, treatment, netting or feeding operations.

Until the captive whale began feeding, its actions were extremely difficult to observe because it was only visible a few seconds at the surface before it disappeared a minute or more in the cloudy water (Text-fig. 1). The longest recorded period of submergence was 3 minutes, 36 seconds. After the whale began feeding on September 9, it tended to make shorter dives (Text-fig. 2).

It moved at a constant rate of speed (2 or 3 knots) in a counterclockwise direction without ever apparently resting. While in the drydock, it was observed by many people throughout the day and was not seen to vary from its pattern of swimming in circles. When is was transferred to its new pen, guards were posted 24 hours a day to protect the whale from the public. These guards also never observed any cessation of movement. In contrast to this, the whales in Johnstone Strait were seen occasionally resting at the surface for brief periods.

It is strongly suspected from this that killer whales do not experience deep sleep but the low salinity and concomitant low buoyancy at the enclosure may have necessitated constant movement and prevented resting at the surface.

The behavior of the captive animal underwent a considerable development as it recovered from its injuries and adjusted to captivity, although it went into a decline just before it died. During August, it was seen slapping its flukes and flippers on the surface of the water and occasionally leaping. After it began feeding,



Text-fig. 2. Duration of submergence (apnea) in captive *Orcinus orca* after initiation of feeding on three separate days.

this behavior was seen more often. It quickly learned where to obtain a fish and became responsive to its feeder. It became tame in the sense that it grew less wary and afraid of man and at no time gave any indication of aggressive tendencies.

Lob-tailing and flipper-slapping frequently took place during a feeding period if an insufficient amount of food was presented to the whale or if for some reason there was a delay in the middle of the feeding. These behavior patterns seemed to indicate annoyance.

Jumping was observed on three occasions between 10:00 a.m. and noon in association with feeding (Fig. 9). On each occasion the animal jumped almost clear out of the water several times. It was also seen to jump early in the morning (4:30–7:00 a.m.) by the guards on various occasions.

Compared with *Tursiops,* the captive *Orcinus* was large and clumsy, with poor maneuverability and little facial expression. Ability to flex its head was very limited, although it could "bend its neck" up and down and back and forth very slightly. As it bent its head downward, folds became apparent under its neck. When a fish was suspended in the water, the whale would often move alongside and examine it with one eye. This required a certain adjustment of the head which was done with great effort because of the considerable momentum of the large body and the limited flexure of the head.

Some playfulness was observed. Many live fish had been released in the pen and one day, about a week after the whale began feeding, it was seen chasing a 7 kg. lingcod at the surface. The whale would seize the fish and toss it a meter or more, then chase it, seize and toss it again. This continued for about 10 minutes before the fish was eaten.

Respiration was accompanied by a noise of very short duration consisting of a soft expiration and a short, sharp inspiration. The spout resembled a vertical puff of steam 2 to 3 m. high (Fig. 10).

General Care of the Whale

The harpoon wound developed a mucus-like discharge for the first few days. Penicillin was given twice during this period. The rope itself, when withdrawn from the wound, showed no evidence of purulent material and did not culture pathogens.

Attention during the early stages was primarily directed at means for stimulating appetite. Thiamine was given both as a vitamin and as an appetite stimulant. Atarax and vitamin

B_{12}, also thought to be helpful for this purpose (personal communication from David Brown), were tried. None of these measures seemed to help and for many weeks a pessimistic outlook prevailed regarding the possibility that the animal would commence to eat. The animal became very noticeably thinner during its fast.

After approximately one month in the Jericho pen, the skin began to deteriorate from its smooth, coal-black sheen gradually to one covered with dull gray annular and configurate coarse granular keratotic lesions, about 8 to 40 cm. in diameter, interspersed with sparse discrete granulomatous nodules about 5 to 8 cm. at the base and elevated 1 to 3 cm. (Fig. 5). The lesions seemed to commence at first from areas which had been superficially scratched at the time of netting, but they soon spread to most regions of the body, including the white ventral surface. The lesions seemed superficial and, while unsightly, were not considered a serious threat to the animal's life.

Four weeks prior to the death of the whale scrapings were taken of the skin lesions. Cultures established that these were due to a fungal infection, that the fungus grew best at 21°C and in one percent salinity. The fungus could not be cultured at a saline content equivalent to ocean water and grew poorly at 36.6°C.

It was hoped that the improved nutritional status following initiation of feeding would help to clear up the fungal infection, but the lesions continued to develop. They appeared to advance with extreme rapidity in the week prior to death. Copper sulfate was applied daily with a brush for a period of 15 days to certain regions of the body to see if this would inhibit the fungus, but this was without apparent effect.

Laboratory and Autopsy Findings

Physical data on the whale are recorded in Table 2. The whale measured 467 cm. from the tip of the snout to the notch of the flukes. It weighed 1,040 kg. and was a male. During life, its sex had not been determined, although it had been suspected of being a female because of its small size. (The name "Moby Doll" had been chosen in a radio contest, creating an awkwardness when the sex was finally learned.).

Despite the fact that the animal had consumed approximately 1,600 kg. of fish in the month prior to its death, it was emaciated. The outline of the ribs was clearly visible in the thoractic region. Its blubber was thin, being about 3 to 5 cm. thick around most parts of the body.

The harpoon wound had healed well with no sign of infection or fistula formation. It had entered on the left lateral side of the body, just at the posterior aspect of calvarium. It went through muscle and blubber and produced a chip fracture of the occipital bone. The chip was about 5 cm. in diameter, involving only the external table.

Table 2
Physical Measurements of Subadult Male *Orcinus orca*

Length of body		467 cm.
Snout to blowhole		72 cm.
Snout to eye		57 cm.
Snout to dorsal base		206 cm.
Snout to flipper		97 cm.
Length of gape		49 cm.
Height of dorsal fin		57 cm.
Ant.-Post. Length of dorsal at base		53 cm.
Width of flipper		40 cm.
Length of flipper		66 cm.
Tail notch to top of dorsal		241 cm.
Tail notch to umbilicus		180 cm.
Tail notch to anus		149 cm.
Tail notch to genital opening		180 cm.
Width of flukes		53 cm.
Length of flukes		127 cm.
No. of teeth:		
mandible—11 on ea. side)		
maxilla —11 on ea. side)		44
Weight of body		1040 kg.
Liver		45 kg.
Lungs	L.	10 kg.
	R.	9.34 kg.
Heart		6.8 kg.
Spleen		.92 kg.
Brain		6480 g.
Kidneys	L.	3680 g.
	R.	4200 g.
Testes*	L.	183 g.
	R.	156 g.
Adrenals*	R.	132 g.

*Weight taken after preservation for one month in 10% formalin.

Multiple nodules were found in the lung, subpleural in location, ranging up to 2.5 cm. in diameter. Cultures from these nodules grew a fungus, tentatively identified as *Aspergillus fumigatus*, as well as *Staphylococcus aureus* and *Proteus*.

Microscopic section of the lungs showed a heavy collection of inflammatory cells, mainly polymorphonuclear leukocytes with numerous macrophages surrounding the nodules. In some areas definite branching mycelia, which were budding, could been seen.

Large lymph nodes, ranging in size from 6 to 10 cm., were located in the neck. Granulomatous lesions in these enlarged nodes cul-

Table 3
Blood and Serum Values

Whole Blood	*Sample 1*	*Sample 2*	*Serum*	*Sample 1*	*Sample 2*
Hemoglobin gm. %	—	11.3	Protein gm %	—	10
White Blood Count	5500	7200	Albumin gm. %	—	2.4
Polymorphs %	61	33	Globulin gm. %	—	7.6
Staff cells %	10	21	Chloride meq/1	—	95
Eosinophils %	8	1	Sodium meq/1	—	148
Lymphocytes %	16	38	Potassium meq/1	—	12.3
Monocytes %	2	4	Phosphate meq/1	—	8.1
Hematocrit %	—	37.5	Uric acid mg. %	—	0.6
Carbohydrate mg. %	114	112	Cholesterol mg. %	—	280
Urea nitrogen mg. %	—	47	Phosphatase (King Armstrong units)	—	2.8
Creatinine mg. %	—	1.5	Amylase	—	<4
Plasma cells %	—	3	Glutamic-oxalic transaminase units	—	45
			Lactic dehydrogenase units	—	755
			Thymol turbidity units	—	1
			Thymol flocculation units	—	0

tured *Aspergillus, Staphylococcus* and *Proteus.* Microscopic sections showed an accute inflammatory reaction to be present.

Each kidney contained a mycotic abscess, measuring about 4 cm. in diameter. Microscopic sections showed mycelia with inflammatory cells in the abscess with complete destruction of normal tissue.

The liver had one lobe with no gall bladder. It appeared normal grossly, but microscopic sections showed an infiltration with polymorphs and plasma cells. No evidence of parasites was seen.

The stomachs were all heavily infested with nematodes tentatively identified as *Anasakis simplex,* a common parasite of the Pacific cod, which constituted the main diet of the whale in captivity. The rest of the gastrointestinal tract appeared normal.

The spleen, pancreas, heart, bladder, adrenals and genitalia all showed no evidence of pathology.

The skin was extensively covered with the shallow annular and configurate lesions previously described. These were found to be entirely superficial and cultured the same unidentified fungus that had been found from the previous skin scrapings.

The most striking organ was the brain. It weighed 6,450 g., a remarkable size for this animal. It approached weights reported for some of the largest species of whales (Lilly, 1964). The only other brain weight of *Orcinus* so far recorded was that of a Southern California specimen (Caldwell & Brown, 1964), a female, 521 cm. in length, in which the brain weighed only 4,500 g.

The cortex was extremely large and well developed with extensive convolutions. There were two very tiny necrotic patches on the occipital surface of the cortex, possibly reflecting a minor degree of damage incurred at the time of the chip fracture to the skull. Details of the anatomical dissection of the brain will be reported separately. Catecholamine and serotonin values were obtained for a number of areas and fell in the range already reported for other mammalian species.

Table 3 gives various values for whole blood and serum. Sample 1 was taken at the time the animal was netted and Sample 2 at the time of autopsy. Many of the values are remarkably close to human values. The probable explanation for the high serum values for potassium, phosphate, lactic dehydrogenase and glutamicoxalic transaminase is that Sample 2 was not obtained until five hours after death, but abnormal levels ante mortem cannot be ruled out. The serum uric acid was much lower than in humans, yet crystals morphologically identical with urate appeared in the urine upon cooling.

Serum protein values were grossly different from the human on chemical fractionation. Electrophoresis established that there was markedly less true albumin and markedly greater globulin. The significance of this finding to the pathology is hard to judge in the absence of normal serum protein values for the killer whale. In the second blood specimen, but not the first, 3% plasma cells were found. Plasma

cells are occasionally seen in the peripheral blood of humans suffering from severe infections. There was a mild shift to immature polymorphs in the first blood sample and a high eosinophil count. In the second specimen, the shift to immature cells was more marked, but the eosinophil count dropped.

The urine values given in Table 4 are comparable in most respects to other mammalian species. Sodium and potassium values are not high, in keeping with a previous report for humpback whales (Bentley, 1963). This is further reinforcement for the notion that whales obtain their water from food and metabolism and do not drink seawater.

Aliquots of the urine were desalted and solvent extracted for paper chromatography. The amino acid chromatogram was quite similar to that of human and rat urine. Chromatograms of the indoles, phenolic acids and phenolic amines showed great difference, however. Generally speaking, there were far fewer compounds appearing in the whale's urine, probably reflecting the lack of vegetable products in the diet.

Examination of the skeleton revealed that the animal was very young. Carpals were almost non-existant and bone centers were very small. There was much cartilaginous material.

During the dissection, the rather narrow amount of jaw opening possible, the marked lack of jaw mobility, the strong, dense, connective tissue surrounding the temporal mandibular joint and the relatively minor amount of tooth wear became evident. Once the muscles of mastication had been completely removed from the mandible, it was possible to open the jaw to 37 cm. measured between the most anterior points on the maxillary and mandibular alveolar crests. Further opening was prevented by strong ligamentous attachments between the mandible and other bones of the head. It was not possible to move the mandible laterally more than a centimeter either side of the midline at the anterior end of the mandible.

Wear facets were noted on all of the teeth occurring for the most part on both mesial and distal surfaces. It has been reported by Carl (1946) that wear has been observed primarily on the anterior or mesial surface of the lower teeth and the posterior or distal surface of the upper teeth. This condition was noted on several individual teeth in the Vancouver specimen. Wear on buccal and lingual surfaces was not prominent. This has been reported and has been ascribed to the "varied lateral position of the free-moving opposing lower jaw" (Caldwell & Brown, 1964). Explanation of such wear on the basis of mandibular mobility does not seem tenable in the light of structures observed in the Vancouver specimen. Some loss of tooth structure was noted along the gingival margin of the teeth in the Vancouver specimen particularly on the lingual surface.

Table 4
Urine Values

Specific gravity	1.024
Sodium meq/l.	58
Potassium meq/l.	65
Creatinine mg/ml.	0.58
Indican mg/100 ml.	1.4
Uric acid mg/ml.	0.29

Due to the thick inflexible nature of the lips and skin, in order for the animal to open his mouth, it is necessary to have some specialized structures allowing elongation of the corner of the mouth. This is accomplished in part by overlapping of the upper and lower lip and also by the presence of cracks or folds at the external side of the corner of the mouth. No ecto-parasites were found in these folds.

Discussion

Orcinus orca is one of the largest predatory animals that has ever existed and it may be the largest carnivore ever to feed on mammals. Its wolf-pack tactics used in hunting marine mammals are well known. The great abundance of killer whales in the inner passages of British Columbia may account for the scarcity there of other cetaceans, very few of which, with the exception of the harbor porpoise and occasionally the minke whale, are ever seen in the Strait of Georgia. Scheffer & Slipp (1948) consider *Orcinus* as a serious factor affecting California gray and other baleen whales on the North Pacific coast. Yet the young specimen captured at Saturna Island preferred fish to mammalian flesh.

The boldness and ferocity which is so much a recognized part of the behavior of the wild killer whale contrasted greatly with the apparent harmlessness of the captive specimen.

The immaturity, wounded condition and isolation of the animal probably affected its behavior considerably. Its immaturity may have accounted for its lack of aggressiveness. Its wounds and subsequent skin afflicitions may have retarded its adjustment to captivity and delayed initiation of feeding. Isolation may well have repressed the degree of playfulness one would expect to find in a young delphinid.

Support similar to that given the wounded and stunned whale by two other members of its pod has been described in many cetaceans (Norris & Prescott, 1961), and this behavior has even been described between two different genera (Caldwell, Brown & Caldwell, 1963). This seems to be, however, the first time it has been observed in *Orcinus orca.*

Killer whales have been benign to man. They are very common in the inside passage of British Columbia, with innumerable contacts between whales and fishermen, but they have never been reported to upset or damage boats of any size in the area, nor have they ever been reported to attack swimmers or skin divers. Stephens (1963) reports six known encounters between divers and killer whales in various parts of the world without the former being threatened or harmed in any way. The report of Marineland collectors, whose boat was struck by an orca in 1962, is an exception.

Cook & Wisner (1963) related the story of a fisherman aboard a boat off Long Island, New York, who cast a hand-held harpoon into the back of a killer whale that approached the boat. The whale pulled free of the harpoon and then followed the boat until it reach shallow water. It never struck the boat or manifested any retaliatory actions, although the people in the boat described their terror at being followed.

Severe tooth wear in adults has been described by Carl (1946) and by Caldwell & Brown (1964). This wear must be a serious debilitating factor affecting the predatory and feeding behavior of the adult. Possibly this explains the preference for the tongue of the great baleen whales. Such tongues consist of soft, watery tissue which would be relatively easy to tear by blunt, worn teeth.

Hancock (1965) described an attack by seven killer whales on a rorqual near Vancouver Island. He said that the two calves, which were about 4 meters in length, remained close to the females while the three males were 300 meters ahead when first observed. Very little could be observed at the surface while the orcas were killing and devouring the rorqual. Later, the corpse was found to be lacking the tongue and the entire outer skin. The body was intact except for a small tear in the abdomen. It would be valuable to have more field observations on their feeding behavior.

The refusal of the animal to take any food for 54 days after capture was extremely frustrating. It has been observed (Brown, 1962) that pilot whales seem to withstand prolonged fasting with far less weight loss than the small delphinids. One of these animals survived 14 days of fasting without apparent weight loss.

It is not possible to say with certainty why the whale died. The most striking pathological findings were the mycotic infection of the lungs, kidneys and lymph nodes, plus an indication of secondary bacterial infection in these areas. The white blood count showed a distinct shift to the left but not an extreme elevation in count. The infection of the skin was from a different fungus than that infecting the lungs, kidneys and lymph nodes. Although it looked severe, it was nevertheless entirely superficial and probably did not contribute to the death of the whale. The same could be said for the nematode infestation. While heavy, it was entirely confined to the stomach. Such infestations are compatible with good health in many species.

The pathological findings would seem to indicate death from a widespread mycotic infection with a superimposed terminal bacterial infection. There were other obvious contributing factors. The extended fast depleted body reserves. The enervating effects of acute mycotic and bacterial infections together with the debilitated condition of the animal probably led to exhaustion and drowning in the water of low salinity.

Although the saline content varied considerably during the time the animal was in captivity and although the water was often muddy, there was no evidence of clouding of the cornea, which has been reported to occur in dolphins and some seals kept under conditions of low salinity.

The size of the brain and the high degree of development of the cortex would suggest the possibility of advanced intelligence of this species. It seems highly probable that they could be trained and that they would not be particularly dangerous.

Methods for capturing killer whales need to be devised. It was extremely lucky that this particular animal was not killed by the initial harpoon shot. Had the harpoon struck slightly caudally, it would have penetrated the cervical cord. Slightly rostrally, it would have penetrated the brain.

The water in which the whale was maintained was obviously unsuitable. What special problems might accrue in the way of warding off infection and devising a thoroughly suitable diet, still remain to be determined.

Summary

1. A young, male killer whale *(Orcinus orca)* was harpooned at Saturna Island, Strait of Georgia, British Columbia, and towed to Vancouver where it was maintained alive for 86 days.

2. The captive whale fasted 54 days after which it began eating 45-90 kg. of fish per day. It became fairly tame and could be fed by hand.

3. Its behavior consisted mainly of counterclockwise swimming, during which it was submerged out of sight for an average period of 90 seconds with only a few seconds at the surface for respiration.

4. Two distinct types of sound were produced. One type consisted of clicks, evidently concerned with echo location. The other consisted of whistles and squeaks, presumably a form of communication.

5. Soon after capture, the whale was given 30 million units of S.R. penicillin. Six days later, it was given a further injection of 15 million units of S.R. penicillin and one gram of thiamine. Three weeks after capture, it was netted, injected with an additional 30 million units of S.R. penicillin, one gram of thiamine, 1.5 mg. of vitamin B_{12} and one gram of atarax. A blood sample was taken at this time.

6. Annular, keratotic lesions began to appear on the skin late in August and grew progressively worse.

7. The whale died on October 9, at which time the salinity of the water in its enclosure was only 12 per thousand, one-third that of the open ocean. Nodules in the lung, lymph nodes and kidneys following autopsy cultured *Aspergillus, Staphlyococcus* and *Proteus*. The stomach was heavily infested with nematodes.

8. Maximum jaw opening was 37 cm. Lateral jaw movement was only a centimeter. There were 11 teeth in each quadrant. Wear facets existed on both mesial and distal surfaces.

9. The experience indicated the feasibility of maintaining and possibly training killer whales in captivity.

Acknowledgments

The whale was harpooned by Mr. S. Burich and Mr. Josef Bauer. Its capture was made possible through the cooperation of Mr. C. Levelton and Capt. M. Gay of the Department of Fisheries and Mr. P. H. Quinney and Mr. P. Fletcher of the East Point Light House. Burrard Drydock facilities were made available by Mr. David Wallace. Lt. Col. W. H. V. Matthews permitted the construction of a pen at the Jericho Military Base. Major H. Robertson (retired), Capt. J. C. Grey (RCN), Lt. Comdr. A. Rowse (RCN) organized the construction of the pen. Medical assistance and advice in the care of the whale was freely given by Drs. J. H. Sturdy, R. A. McKechnie, W. H. Cockroft, D. H. Williams, John Eden, D. G. Middaugh, W. C. Gibson and R. A. English. Data were supplied by Mr. Ian MacAskie, Mr. Gordon Pike, Mr. M. Bigg, Dr. J. H. Sturdy, Dr. R. A. English, Dr. W. H. Cockroft, Dr. John Eden, Dr. H. D. Fisher, Dr. D. G. Middaugh, Dr. E. G. McGeer and Dr. J. R. Adams. Assistance with the manuscript was given by Dr. H. D. Fisher, Mr. V. Penfold and Mr. J. Bauer. The Royal Canadian Navy at Esquimalt loaned sound equipment. The Leon and Thea Koerner Foundation and the Vancouver Public Aquarium Association provided grants.

Addendum

An adult male *Orcinus orca* and a juvenile were accidentally trapped within a gillnet at Namu, British Columbia, in June, 1965. The small specimen escaped but the large one (Fig. 11) was purchased by Edward I. Griffin, who built a floating cage 60 x 40 x 16 feet deep and transported the animal to Seattle, a distance of 450 miles. The animal, which was 21.5 feet long and weighed 7,800 pounds, quickly became tame and permitted divers to swim with it, never manifesting predatory or aggressive inclinations. It ate mainly salmon, consuming 300-400 pounds per day. It died July 9, 1966.

A small female, about 14 feet in length, was captured by Griffin in Puget Sound in November, 1965. This specimen was flown to San Diego where it is on public exhibit in an oceanarium. It is quite tame, eats only fish and has learned to perform various tricks including leaping out of the water for its food.

References

Bentley, D. J.

1963. Composition of the urine of the fasting humpback whale. Comp. Biochem. Physiol., 10: 257-259.

Brown, D. H.

1960. Behavior of a captive Pacific pilot whale. Jour. Mamm., 41 (3): 342-349.

1962. Further observations on the pilot whale in captivity. Zoologica, 47 (1): 59-64.

Brown, D. H., R. W. McIntyre, C. A. Delli Quadri & R. J. Schroeder

1960. Health problems of captive dolphins and seals. 137 (9): 534-538.

Brown, D. H. & K. S. Norris

1956. Observations of captive and wild cetacea. No. 1. Jour. Mamm., 37 (3): 120-145.

Caldwell, D. K. & D. H. Brown

1964. Tooth wear as a correlate of described feeding behavior by the killer whale, with notes on a captive specimen. Bull. Southern Calif. Acad. Sci., 63 (3): 128-140.

Caldwell, M. C., D. H. Brown & D. K. Caldwell

1963. Intergeneric behavior by a captive Pacific pilot whale. Contrib. Sci. L. A. County Mus., 70: 1-12.

Carl, G. C.

1946. A school of killer whales stranded at Estevan Point, Vancouver Island. Rept. Prov. Mus. Nat. Hist. & Anthr. pp. 21-28.

Cook, J. J. & W. L. Wisner

1963. Killer whale. Dodd, Mead. New York 64 pp.

Evans, W. E. & J. H. Prescott

1962. Observations of the sound production capabilities of the bottlenose porpoise: A study of whistles and clicks. Zoologica, 47 (3): 121-128.

Hancock, D.

1965. Killer whales kill and eat a minke whale. Jour. Mamm. 46 (2): 341-342.

Kellogg, W. N.

1961. Porpoises and Sonar. Univ. Chicago Press. 177 pp.

Layne, J. N. & D. K. Caldwell

1964. Behavior of the Amazon dolphin, *Inia geoffrensis* (Blainville), in captivity. Zoologica, 49 (2): 81-108.

Lilly, J. C.

1961. Man and Dolphin. Doubleday, N.Y., 312 pp.

1964. Arrivals in aquatic environments, adaptation of mammals to the ocean. *In:* Handbook of Physiology, Section 4: Adaptation to the Environment. Am. Physiol. Society.

Scheffer, V. B. & J. W. Slipp

1948. The whales and dolphins of Washington State with a key to the cetaceans of the west coast of North America. Amer. Midl. Nat., 39 (2): 257-337.

Stephens, W. M.

1963. The Killer. Sea Frontiers, 9 (5): 262-273.

Wood, F. G. Jr.

1953. Underwater sound production and concurrent behavior of captive porpoises, *Tursiops truncatus* and *Stenella plagiodon*. Bull. Mar. Sci. Gulf and Carib., 3 (2): 120-133.

Explanation of Plates

Pl. I

Fig. 1. Samuel Burich about to fire harpoon at killer whales on July 16, 1964, at Saturna Island, British Columbia. Photo by J. Bauer.

Fig. 2. Head of young male *Orcinus* showing harpoon which passed through muscle and blubber just posterior to calvarium. Photo by D. Middaugh.

Pl. II

Fig. 3. *Orcinus* struggling on harpoon line secured to suspended stage above. Note white undersides of flukes. Photo by D. Middaugh.

Pl. III

Fig. 4. Injecting penicillin into the animal with syringe at the end of a pole.

Pl. IV

Fig. 5. Side of whale showing annular keratotic lesions on skin.

Pl. V

Fig. 6. The whale seizing a Pacific cod from the hand of the senior author. Photo by Brian Kent.

Pl. VI

Fig. 7. Sonograph of whale's whistling sound.

Fig. 8. Sonograph of navigational clicks.

Pl. VII

Fig. 9. Whale leaping out of water.

Pl. VIII

Fig. 10. The spout resembled a vertical puff of steam 2 to 3 meters high.

Fig. 11. Edward Griffin swimming with the adult male killer whale at the Seattle Aquarium.